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RESEARCH OF ZINC CONCENTRATE OXIDATIVE ROASTING PROCESS

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Preliminary Note – Prethodno priopćenje

In this work, the tests on the oxidative roasting process of zinc sulphide and zinc sulphide concentrate were carried. When zinc sulphide ores are used in the proces of obtaining the metalic zinc, then oxidative roasting operation is always a preliminary stage of the basic zinc production process. Both by the hydrometallurgical and by the pyrometallurgical method.

Keywords: zinc, zinc sulfide, zinc concentrate, oxidative roasting, thermogravimetric analysis (TG)

INTRODUCTION

Zinc, next to iron, aluminum and copper, is in the top four in terms of production volume among metals in the world. Currently, zinc, from primary sources, is obtained by two methods. The first method is a pyrometallurgical process in which zinc oxide is reduced in a shaft furnace. The second method that is leading in the world is the hydrometallurgical proces, the final stage of which is electrolysis. In both technologies, when sulphide ores are used, the basic process of zinc production is preceded by the oxidative roasting of zinc sulphide concentrates, which were produced as a result of enrichment of zinc-bearing ores, most often by flotation [1, 2].

The zinc sulphide concentrate consists mainly of ZnS. During roasting, the following reactions may occur:

$$ZnS + 1{,}5O_2 \rightarrow ZnO + SO_2 \quad (1)$$

$$SO_2 + 0{,}5O_2 \rightarrow SO_3 \quad (2)$$

$$ZnO + SO_3 \rightarrow ZnSO_4 \quad (3)$$

$$ZnS + 2O_2 \rightarrow ZnSO_4 \quad (4)$$

$$3ZnSO_4 + ZnS \rightarrow 4ZnO + 4SO_2 \quad (5)$$

On the other hand, the main components of the gangue, i.e. magnesium carbonate and calcium carbonate, undergo a process of thermal decomposition during roasting according to the reaction:

$$MgCO_3 \rightarrow MgO + CO_2 \quad (6)$$

$$CaCO_3 \rightarrow CaO + CO_2 \quad (7)$$

As part of the presented work, research was carried out on the oxidative roasting process of zinc sulphide and zinc sulphide concentrate.

METHODOLOGY

The research material used was zinc sulphide with a purity of 99 % and an industrial sulphide zinc concentrate containing:

- 53,3 % Zn in the form of ZnS,
- 2 % of Pb in the form of PbS,
- 6,6 % Fe in the form of FeO and $Fe2O_3$,
- 0,4 % Cd in the form of CdS,
- 2,1 % $Al2O_3$,
- $MgCO_3$ and $CaCO_3$ – ballance.

In the first stage, thermogravimetric tests (TG) were carried out, allowing to determine the influence of temperature on changes in the mass of the analyzed sample [3, 4]. In this stage of research, a Netzach, the STA 449 F3 Jupiter thermal analyzer, was used. The view of the device is shown in Figure 1. The heating program adopted in the first stage of the research included the gradual heating of samples (with a mass of 250 mg) at a rate of 20 °C / min to selected temperature values (700, 800, 900, and 1000 °C). At each of the given temperatures, the sample was isothermally heated for 30 minutes and then heated to the next assumed temperature value. The research was conducted in an oxidizing atmosphere.

The second stage of the research was carried out in a horizontal resistance tubular furnace for samples weigh-

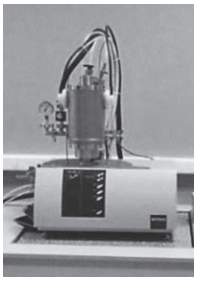

Figure 1 Thermal analyzer

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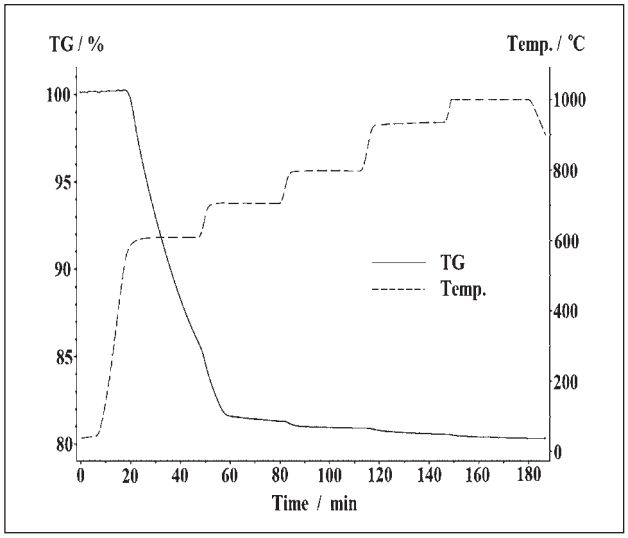

Figure 2 TG curve for ZnS

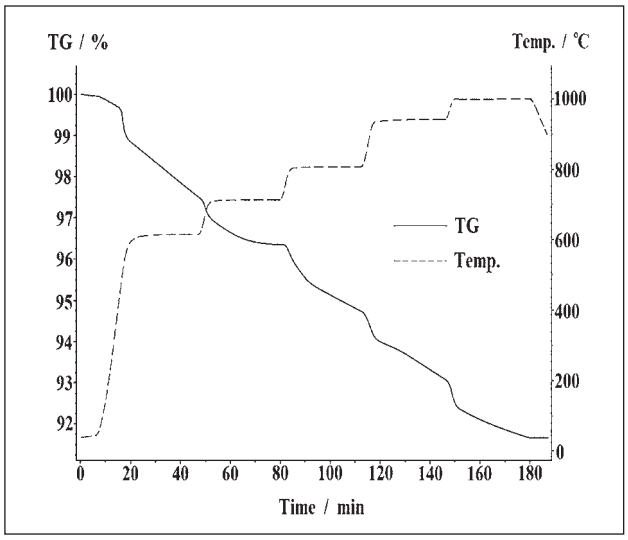

Figure 3 TG curve for zinc sulphide concentrate

ing of 1 g. The experiments were conducted in an oxidizing atmosphere at temperatures of 700 °C, 800 °C and 900 °C (the temperatures were selected based on the results from the first stage). The duration of the process for each of the temperatures was 5, 10, 15, 20, 25 and 30 minutes.

RESEARCH RESULTS

Figures 2 and 3 show the results of thermogravimetric tests with the use of ZnS and industrial zinc sulphide concentrate.

The test results obtained in the second stage of the tests with the use of a horizontal tube furnace for zinc sulphide and zinc concentrate are presented in Figures 4-6.

SUMMARY

By analyzing the obtained thermogravimetric curve for the ZnS sample, it was found that the oxidative

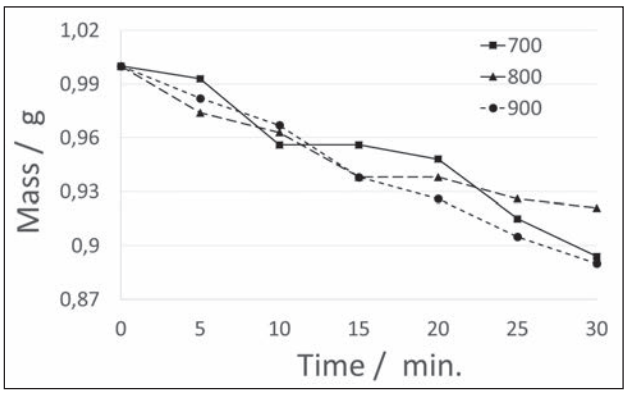

Figure 4 Changes in sample weight during the roasting of zinc sulphide in a horizontal tube furnace

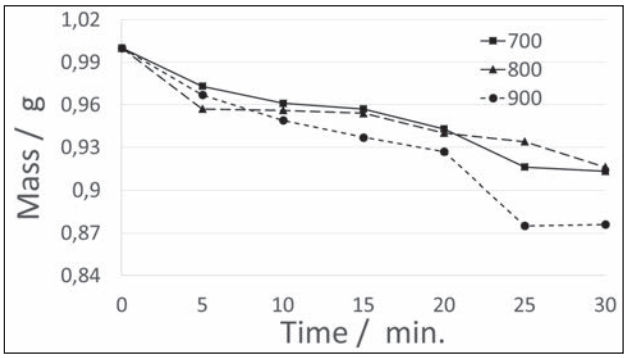

Figure 5 Changes in sample weight during the roasting of sulphide zinc concentrate in a horizontal tube furnace

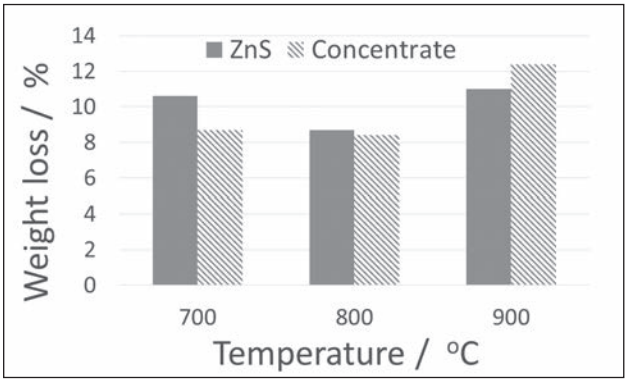

Figure 6 Weight loss of ZnS samples and zinc sulphide concentrate after 30 minutes of roasting in a horizontal tube furnace

roasting process of zinc sulphide was characterized by a quick and one-stage loss of sample mass, and its mass stabilization was achieved after exceeding the temperature of 700 °C. For the concentrate sample, the roasting process was gradual and much slower than in the case of pure ZnS. This phenomenon is mainly related to the complex chemical composition of the concentrate (e.g. the content of calcium carbonate) and the fact that it contains less zinc sulphide.

In the oxidative roasting of zinc sulphide in a horizontal tube furnace, the time course of the process was similar at all temperatures. The same can be said about the course of the oxidative roasting process of zinc con-

centrate. The highest weight loss of samples in the processes carried out in this furnace was recorded at the temperature of 900 °C. Moreover, the mass losses of samples at 800 °C are lower than at 700 °C and 900 °C, which may indicate that under these conditions one of the reaction products, apart from ZnO, may be $ZnSO_4$.

Acknowledgments

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Note: Nowak P. is responsible for English language, Katowice, Poland